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INDUSTRIAL PLANTS II

Chapter six (part 1): Electrical plants

**DOUBLE DEGREE MASTER IN
“PRODUCTION ENGINEERING AND MANAGEMENT”**

**CAMPUS OF PORDENONE
UNIVERSITY OF TRIESTE**

Electrical plants

Generality

The **electrical systems** are the set of electrical, mechanical and physical equipments suitable for transmission and use of electrical energy. The CEI 64-8* defines the electrical system as the set of electrical components, having characteristics coordinates, electrically associated in order to meet specific purposes, not part of the electrical equipment users fed from the plug sockets, at unless they are secured to the building structure or other fixed structures.

The **using plant** has originated in the user point of delivery of electric power distribution Company or of group generator.

* Norm CEI 64-8/2 on "Electrical plants user a nominal voltage not exceeding 1000 V in alternating current and at 1500 V in direct current"

Electrical plants

Generality

For ***system component**** is defined any element used in the production, processing, transmission or distribution of electrical energy, such as machines, transformers, apparatus, measuring instruments, protective equipment and pipelines.

For ***user device**** is defined that device that transforms electrical energy into another form of energy, for example light, caloric and mechanical energy.

The general term used for ***electrical component**** indicates both components of the plant, both user equipment.

* Norm CEI 64-8/2 on "Electrical plants user a nominal voltage not exceeding 1000 V in alternating current and at 1500 V in direct current

Electrical plants

Generality

Normally for electrical plants are considered the plants of low voltage (LV), while for the plants of medium voltage (MV) and high voltage (HV) you prefer to speak of **electrical grids** or **electrical systems** given of the greater complexity both of the technological equipment, both of the studies and calculations required.

Electrical plants

Regulations

This is regulated by a series of laws and decrees. Among these regulations you have the Law n. 186/1968*, which requires the implementation of Electrical and Electronic plants, installations and equipment "at workmanlike", recognizing at the same time to the CEI the workmanlike. This principle was taken up and developed Ministerial Decree 37 of 22 January 2008** and art. 81 Legislative Decree 81/2008***.

*** Law of 1 March 1968, n. 186 "Provisions concerning the production of materials, equipment, machinery, and electrical installation and Electrical plants" - G.U. n. 77 of 03.23.1968**

**** Decree of the Ministry of Economic Development 22.01.2008, n. 37 of the "Regulations on the Implementation of Article 11-quaterdecies, paragraph 13, letter a) of Law no. 248 of 2 December 2005, laying down provisions for the reorganization of the business of installation of the equipment inside buildings - G.U. n. 248 of 2 December 2005**

***** Legislative Decree 9 April 2008, n. 81 on "Implementation of Article 1 of the Law of 3 August 2007, n. 123, concerning the protection of health and safety in the workplace "- G.U. n. 101 of 30 April 2008**

Electrical plants

Regulations

This principle was taken up and developed D.M. 37 of 22 January 2008 and art. 81 Legislative Decree 81/2008, whose main points are:

- the requirement of the project by a registered professional in the professional not only for electrical plants of real estate for residential purposes and those of condominium services, but for electrical plants of premises used for productive activities (improperly "Electrical industrial plants") , commercial and service sectors if:
 - a) when the equipment is supplied with a voltage greater than 1000 V, including the BT (users with their own cabin);
 - b) when the utilities have committed capacity exceeding 6 kW or if greater than 200 m²;
 - c) where the utilities are located in rooms used for medical purposes or for which there is a danger of explosion or a greater risk of fire, and the systems of lightning protection in buildings with a volume greater than 200 m³.

Electrical plants

Regulations

This principle was taken up and developed D.M. 37 of 22 January 2008 and art. 81 Legislative Decree 81/2008, whose main points are:

- the protection of the user from direct contacts, which are in contact with live parts normally, and indirect, such as metal parts that should not be in tension;
- the requirement of the system grounding;
- the obligation to install the differential switch.

Electrical plants

Regulations

The electrical components and the related supply plants are considered made in a workmanlike manner if they are made in accordance with the standards of good practice, which lead back to the technical specifications of UNI (National Agency for Standardization), CEI (Italian Electrotechnical Committee), CEN (European Committee for Standardisation), CENELEC (European Committee for Electrotechnical standardization) and IEC (International Electrotechnical Commission) and ISO (International Organization for Standardization).

Electrical plants

Regulations

The same plants should be kept in a workmanlike manner, having appropriate procedures for use and maintenance, possibly a timetable; better if an actual "Plan".

In addition, the norms CEI EN50110 e 11-27 of 2005 requiring a specific qualification to the personnel for exercise and work on the electrical plants. The technical monitoring of ground systems and protection against lightning, as well as in areas with danger of explosion, is entrusted INAIL (National Institute for Insurance against Accidents at Work), (according to the D.M. 11.04.2011 is replaced ISPESEL), ASL (Corporate Health Services) or accredited bodies.

The Law of 30 July 2010, no. 122 conversion, with modifications, the Legislative Decree 78/2010, provides for the allocation at INAIL of the functions previously carried out by ISPESEL

Electrical plants

Supply of electrical energy

The electrical energy is a secondary energy source, that is not available as such in nature, but obtained from other primary sources.

The peculiarities of the electrical energy are the remarkable ease of use and transport through power lines, ease of conversion, with simple machines and high yield, into mechanical, light and heat energy, and it is an indispensable element in computer applications and telecommunications.

The main drawback lies in the fact that can not be stored in industrial quantities, only in cells and in the batteries in very small quantities, and therefore must be produced at the same moment in which it is required.

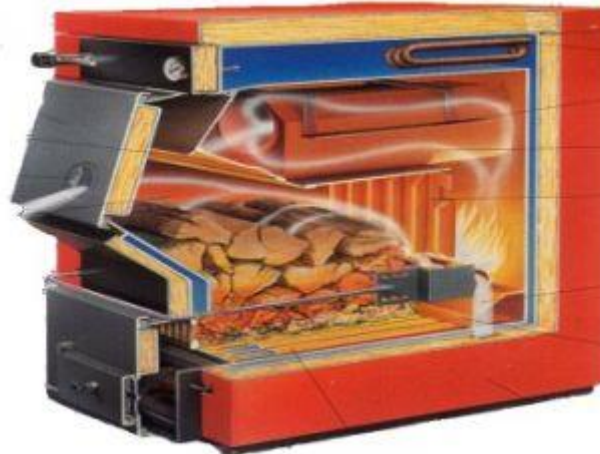
Electrical plants

Supply of electrical energy

Sources from which electrical energy can be produced::

- **thermo-chemical energy generated from traditional fuels: solid, liquid and gaseous fuels (coal, oil, biomass and methane)**

It is a plant for the production of electrical energy through the steam and/or through the gas resulting from the chemical reaction of the fuel and combustion air in a combustion chamber (steam generator or heat). The steam or gas feeds the turbines connected to generators that generate electrical energy.



Electrical plants

Supply of electrical energy

Sources from which electrical energy can be produced::

- **nuclear energy, coming from the fission process**

It is a nuclear reaction in which the nucleus of a heavy element - such as uranium-235 or plutonium-239 - decays into fragments of smaller size, or in the nuclei of atoms with atomic number lower, with the emission of a large amount of energy and radioactivity. Fission may occur spontaneously in nature (spontaneous fission) or be induced by neutron bombardment.

The heat produced by the nuclear fission is controlled to generate steam or gases at high temperatures and pressures to power turbines connected to generators that generate electrical energy.



Electrical plants

Supply of electrical energy

Sources from which electrical energy can be produced::

- **hydropower energy from the water, tides and waves**

Hydropower energy from the water is a source of clean and renewable energy, which uses the transformation of potential energy, which is owned by a certain mass of water, placed in a penstock, to a certain elevation in the kinetic energy overcoming of a certain difference of height; such kinetic energy is eventually transformed, due to a generator coupled to a turbine, into electrical energy.

In-river plants, the water is channeled through a penstock from this point is fed into the turbines which rotate due to water pressure by operating as alternators that convert mechanical energy into electrical energy.



Electrical plants

Supply of electrical energy

Sources from which electrical energy can be produced::

- **hydropower energy from the water, tides and waves**

The energy from the sea is the energy derived from the movement of water caused by tides: which at first and then fill the empty basin with the flow in turbines, connected to generators of electrical energy. This mode of energy production is not the only, but it is certainly the most used. Is a renewable energy source.

The wave energy is a source of electrical energy ranked among the so-called "renewable energy".



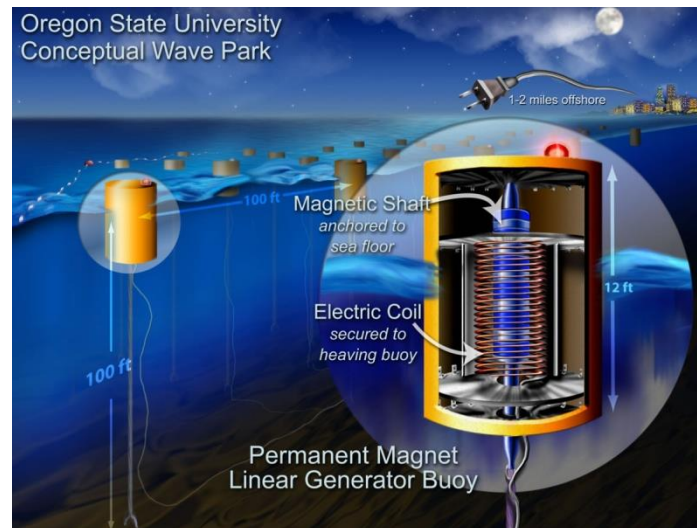
Electrical plants

Supply of electrical energy

Sources from which electrical energy can be produced::

- **hydropower energy from the water, tides and waves**

An example of a system that exploits the wave motion is represented by Pelamis project, which exploits the sinusoidal oscillations of the waves (and therefore the mutual oscillations of the sections of the device) to generate electrical energy through the use of hydraulic pistons and a generator capable of convert these pulses into electrical energy.



Electrical plants

Supply of electrical energy

Sources from which electrical energy can be produced::

- **wind energy**

Wind power is the product of the conversion of the kinetic energy of the wind into electrical energy that is a form of renewable energy.



Electrical plants

Supply of electrical energy

Sources from which electrical energy can be produced::

- **photovoltaic energy**

Photovoltaic plants convert sunlight directly into electrical energy using the photoelectric effect.

The photovoltaic effect, first observed by Alexandre Edmond Becquerel in 1839, is one of the indirect evidence of the particle nature of electromagnetic waves.



Electrical plants

Supply of electrical energy

Sources from which electrical energy can be produced::

- **photovoltaic energy**

The physical theory that explains the photoelectric effect, which is a subcategory of the photovoltaic effect, was published in 1905 by Albert Einstein and for this he received the Nobel Prize for Physics in 1921. When an electromagnetic radiation invests a material can, in certain conditions, transfer energy to the electrons most extreme of the atoms of the material and, if this is sufficient, the electron is free to move away from the atom source.

Electrical plants

Supply of electrical energy

In Italy the production of electrical energy is regulated D.P.R. 18 March 1965, n. 342*, which assign to the ENEL the production and distribution of energy itself, which exception to this monopoly the municipality businesses already producing and providers entities or distributors.

*** Decree of the President of the Republic 18 March 1965, n. 342 "Supplementary Rules of the Law of 6 December 1962 n. 1643 and the rules relating to the coordination and operation of the electrical activity carried out by different organizations and companies by the National Electrical Energy "- G.U. n. 104 of 26 April 1965**

Electrical plants

Supply of electrical energy

The power line (figure) is a network infrastructure designed to allow transmission of electrical energy, including in this sense is the overhead power lines, underground lines in both the cable or the cable ducts.



Electrical plants

Supply of electrical energy

The set of power lines is the primary electricity network, on which are administered the transmission of electrical energy, namely the transfer of high voltage energy over large distances, and the distribution of electrical energy, namely the transfer of energy to medium-low voltage on a capillary network on the territory.

The constitution and characteristics of the transmission lines are highly variable, primarily a function of the operating voltage and in that the transmission takes place in alternating or direct current, now limited to a few lines in cable 200 kV submarine.

Electrical plants

Supply of electrical energy

For high voltage power lines are almost exclusively airplane and are constituted by pylons or tubular made of metal, designed in order to keep the wire ropes (conductor) at a height from the ground sufficiently high to ensure electrical insulation and reduction of electromagnetic fields at ground.

Since the height depends on the operating voltage, medium voltage power lines have the supports are lighter and low height. In some cases, where it is required the crossing of densely populated areas and where this is technically feasible, the power line is built with an underground cable.

Electrical plants

Supply of electrical energy

The transmission in cable may occur predominantly in alternating current, but also in direct current; in fact, are now widespread examples of different national or international connections via submarine cable in direct current.

The elements of a national electricity system are:

- **electrical centrals of generation**, where it produces electrical energy;
- **electric lines of power**, which interconnect the electrical centrals of generation, intermediate nodes of the system and end users;
- **transformer stations and transformation cabins**, which positioned at intermediate nodes, interconnect the various sections of the system;
- **users** (agriculture, industry, trade, commerce, services, electrified transport, street lighting, schools, hospitals, homes, etc.), variously and diffusely distributed throughout the territory.

Electrical plants

Supply of electrical energy

In relation to the rated voltage of that project, the electrical systems are divided into four categories shown in the table.

Category	Nominal voltage between the phases V_n for the current	
	Direct	Alternating
0	$V_n \leq 50 \text{ V}$	$V_n \leq 120 \text{ V}$
I	$50 \text{ V} < V_n \leq 1 \text{ kV}$	$120 \text{ V} < V_n \leq 1,5 \text{ kV}$
II	$1 \text{ kV} < V_n \leq 30 \text{ kV}$	$1,5 \text{ kV} < V_n \leq 30 \text{ kV}$
III	$30 \text{ kV} < V_n$	$30 \text{ kV} < V_n$

A comprehensive set of machinery, equipment and connections, intended at the generation of electrical energy, transformation of its features, its transmission, distribution and use is called the **electric system of power**.

Electrical plants

Supply of electrical energy

The functions of the four parts of the electrical system of power can be classified into:

- **production of electrical energy**, which means transforming the energy obtained from primary sources into electricity. This transformation takes place in **power plants**, production centers of electrical energy;
- **transmission**, which means to transmit electrical energy means to transfer large amounts do energy produced by power plants to the consumption areas. For this to occur requires: **power lines, electrical stations and processing**, namely the elements that compose the **transmission network**

Electrical plants

Supply of electrical energy

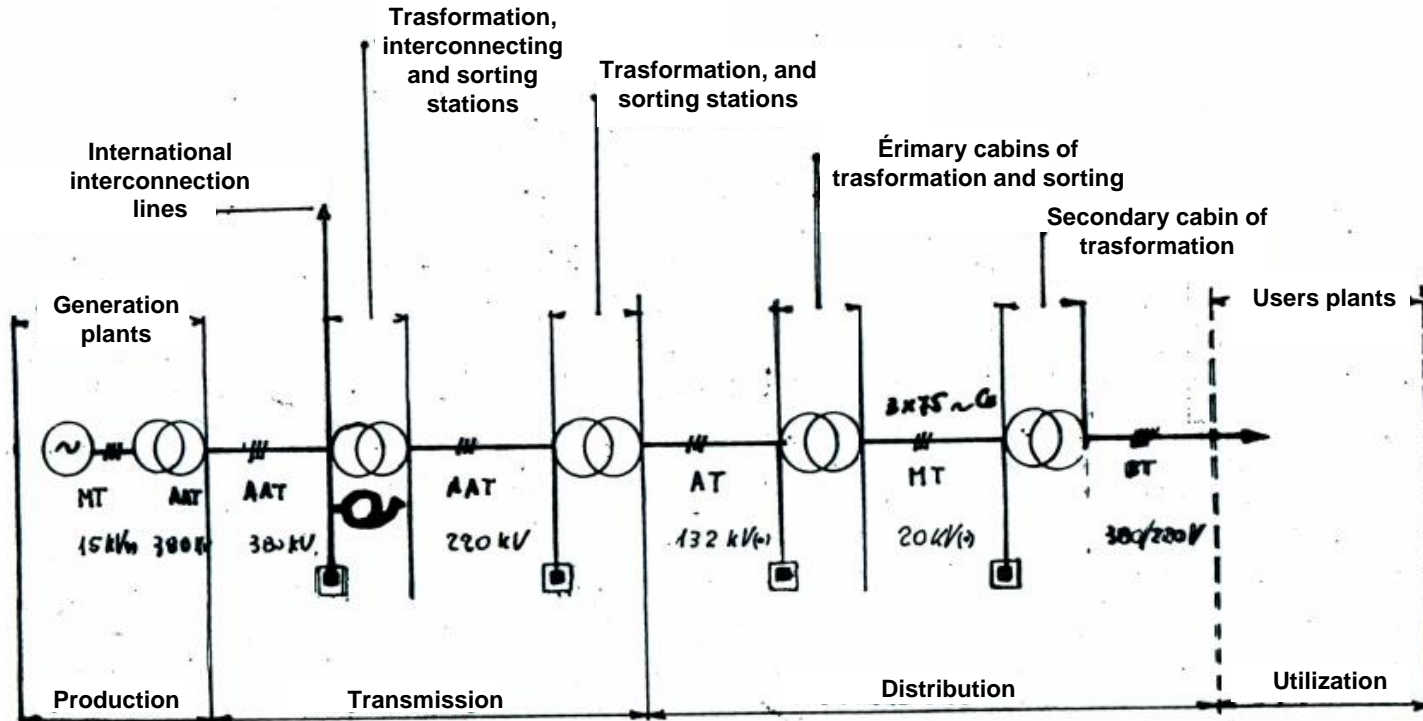
The functions of the four parts of the electrical system of power can be classified into:

- **distribution of electrical energy**, namely the delivery of electrical energy to the users is a further level of transport which affects the connection between the stations, cabins and users;
- **utilization of electrical energy**, namely the transformation of this energy into other form suitable for civil and industrial uses (handling mechanical, lighting, etc.).

Electrical plants

Supply of electrical energy

Single-line diagram simplified of the S.E.D.P. (Electrical system of power)

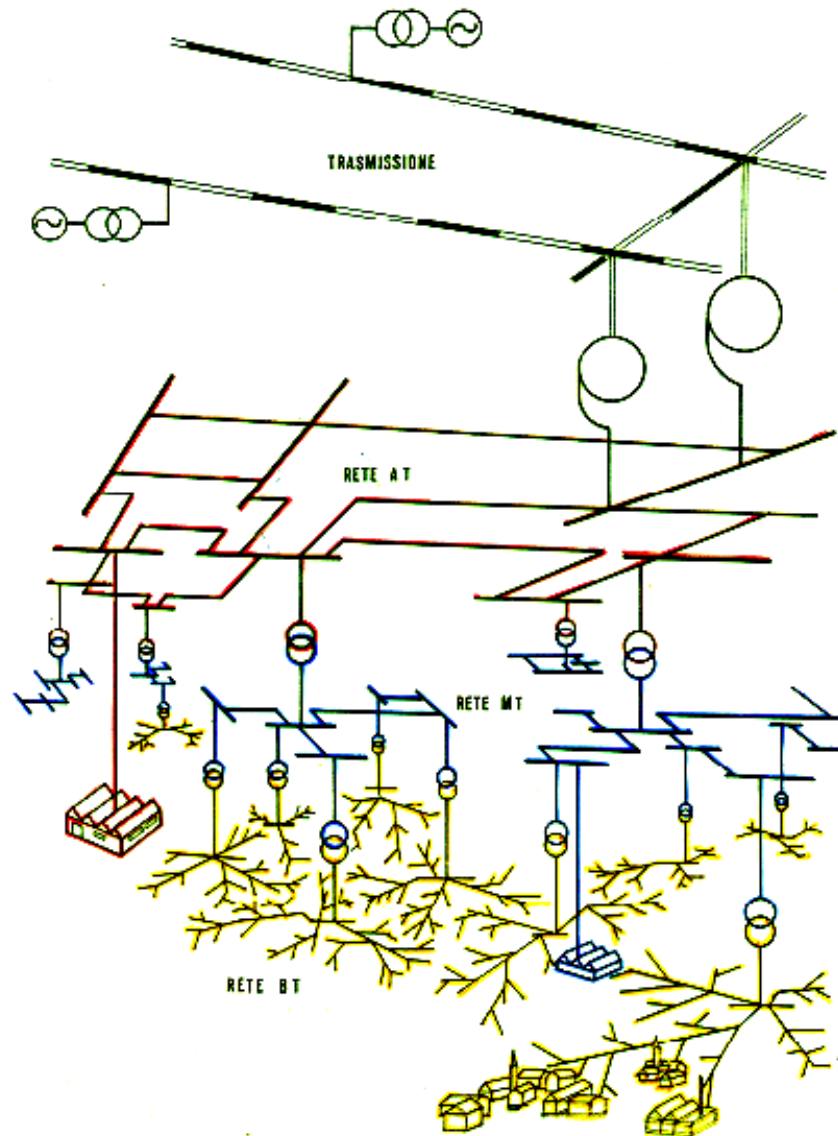


- = Powered directly by users into their own station or transformer cabin
- = Value verified mainly adopter

Electrical plants

Supply of electrical energy

View of the "electric system of power national"



Electrical plants

Supply of electrical energy

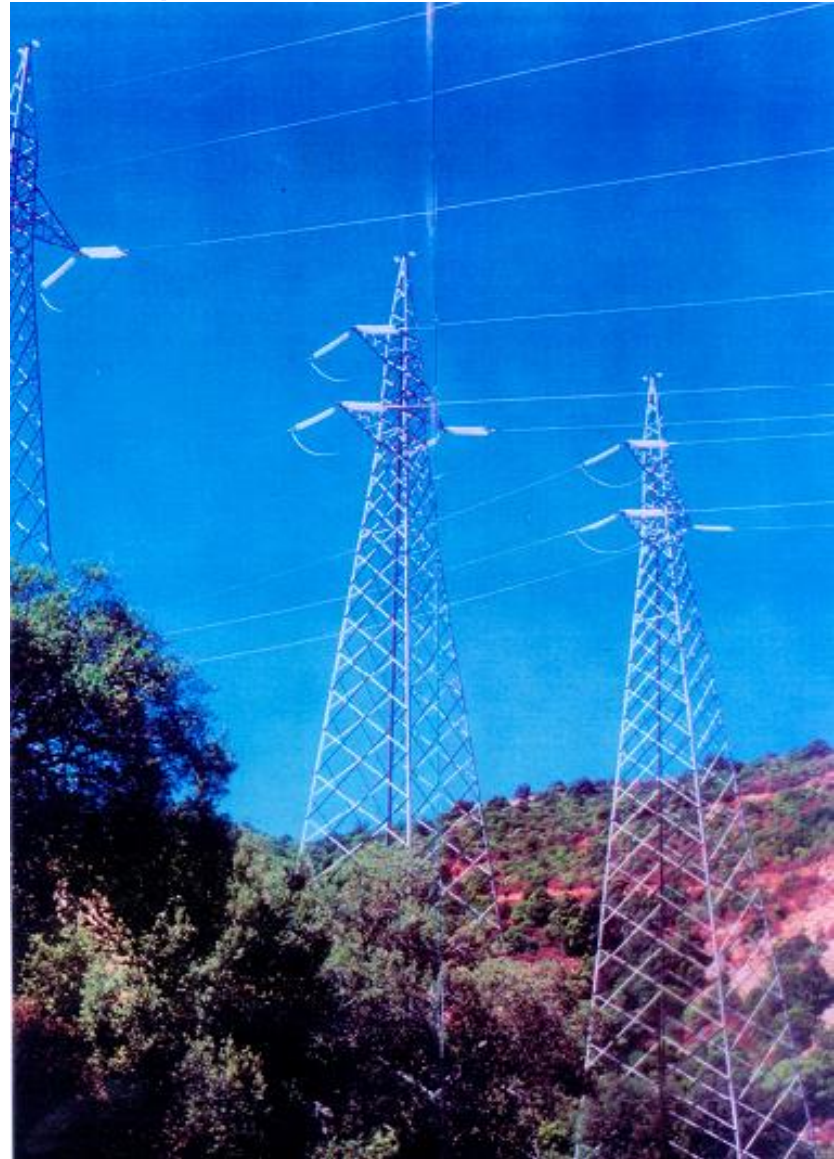
Transmission line to 380 kV



Electrical plants

Supply of electrical energy

Transmission line to 220 kV



Electrical plants

Supply of electrical energy

Transmission line to 130 kV



Electrical plants

Supply of electrical energy

Distribution line at 20 kV



Electrical plants

Supply of electrical energy

Distribution line to BT
(380/220 V) (overhead cable)



Electrical plants

Supply of electrical energy

In general, the distribution of electricity within the industrial establishments may be entrusted to bare overhead lines, cables or channels to bars.

The use of overhead lines is generally limited to the high voltage supply and, therefore, is not expected inside the factories, where operations and maintenance would be subject to unacceptable risks.

Electrical plants

Supply of electrical energy

Tensions energy supply by ENEL or municipal local Company or Distributor are:

- **low voltage BT** (corresponding to 230-400 V) is used for connection to BT, small users (up to about 100-200 kW);
- **medium voltage MT** (10 - 15 - 20 kV) which is employed for the connections in MT, medium users (200 kW up to about 4 - 5 MW);
- **high voltage AT** (132 - 220-380 kV), which is used for connections in AT, large users.

Electrical plants

Supply of electrical energy

The systems of self-production are designed for the following purposes:

- supply of essential systems of the industrial plant;;
- energy savings and lower cost of electricity;
- reduction of peaks of load;
- use of waste production that would otherwise be landfilled (ad example, processing waste wood in the furniture industry).

When the supply occurs in MT is necessary to provide a place for the delivery of the energy and one or more transformer cabins.

Electrical plants

Supply of electrical energy

The place of delivery shall be:

- have the size and the characteristics required by the distributing Company;
- be located on the perimeter of the property of the user with direct access to public land. In any case, the exact location must be agreed with the Distribution Company in order to allow authorized personnel to access to the same to perform the maneuvers of service and maintenance;
- must be adjacent to another room, where you can install the tools for measuring energy and the organs of isolation and protection of the power cable of transformer stations;
- be closed to key.

Electrical plants

Supply of electrical energy

The location of transformation cabins is chosen according to specific needs:

- availability of the local, powers in the game ecc.;
- the position more rational from the standpoint of electric is that next to the barycenter of the loads to be supplied.

For small systems, the transformer cabin is adjacent to the delivery room, for obvious economic reasons.

Electrical plants

Supply of electrical energy

Depending on the construction methods, the cabins are divided into two categories:

- cabins "**to day**", set up on site with techniques and different ways, depending on the location and modality of installer;
- cabins "**prefabricated**", built in the factory and assembled on site with standard modality.

The main rules to which to refer to the design of a transformer cabin are the CEI 11-1 "Electrical plants with voltage exceeding 1 kV in AC, as well as the CEI 0-16 and the guide CEI 0-16"

Electrical plants

Supply of electrical energy

The **transformer cabin** is the set of conductors, equipment and machines that will transform the voltage supplied to the values of the lines to MT at values of the power lines to BT. The figure shows a prefabricated cabin with delivery cabin ENEL or Authorized Distributor) (left door), the local of electrical energy metering (small port) and finally the premises of the transformer cabin of utilities to MT (two doors on the right).



Electrical plants

Supply of electrical energy

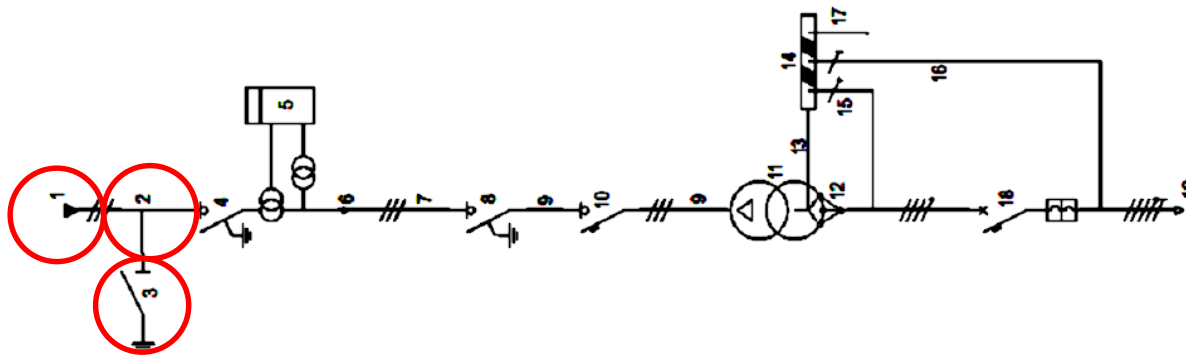
In the electrical cabin is present the **cabin of sorting** or **adjustment**, which allows to derive from one or more incoming lines a greater number of outgoing lines, without performing any processing; it constitutes a branch node of the energy.

Electrical plants

Supply of electrical energy

The constituent elements of a transformer substation with adjoining the local of delivery of a small plant, with a single transformer, are:

- terminal of connection (1), for the connection of cables to equipment MT of the distributing Company;
- conductor of connection (2) to interconnect the devices in MT of the distributing Company;
- earthing knife switch (3), for the eventual grounding of the equipment of the distributing company on the plant floor to the user;

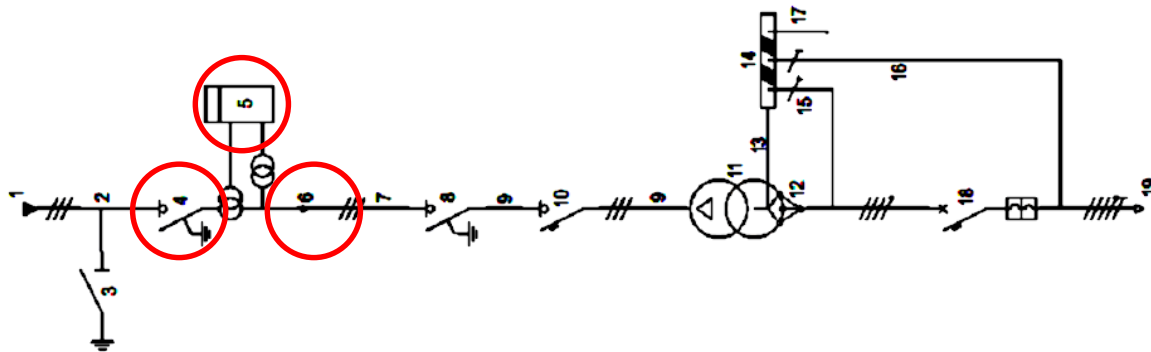


Electrical plants

Supply of electrical energy

The constituent elements of a transformer substation with adjoining the local of delivery of a small plant, with a single transformer, are:

- knife switch of line (4), for the eventual commissioning of the equipment line of the distributing Company on the plant floor to the user;
- measuring group (5), in the local delivery of appropriate and accessible to the user via a repeater of reading connected with optical fiber;
- delivery point (6), set up by the Company making the distribution in the delivery room with restricted access;

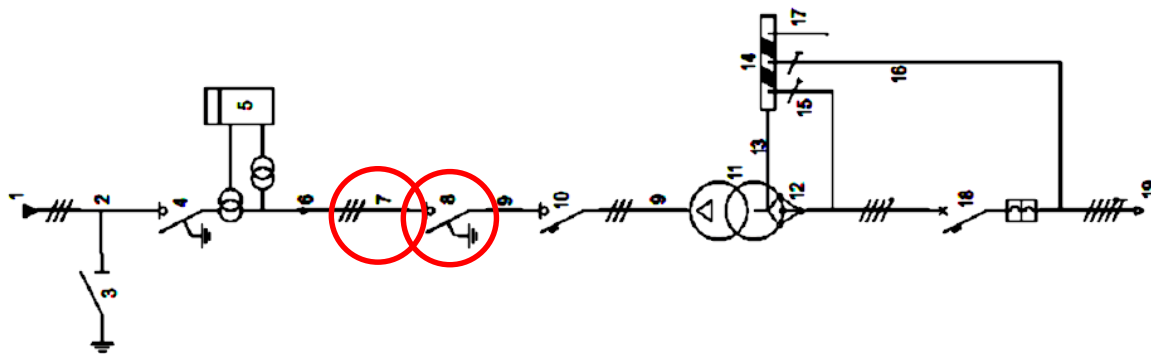


Electrical plants

Supply of electrical energy

The constituent elements of a transformer substation with adjoining the local of delivery of a small plant, with a single transformer, are:

- supply line (7), set up by the user and consists of three single-core cables, whose cross-section and the length of which shall be established by the distributing Company, with metallic screen suitable for the rated voltage of the cabin;
- disconnect knife switch under the type-load (8), unless you install an interlock between the auditor and the circuit breaker, which prevents the maneuver switch is closed;

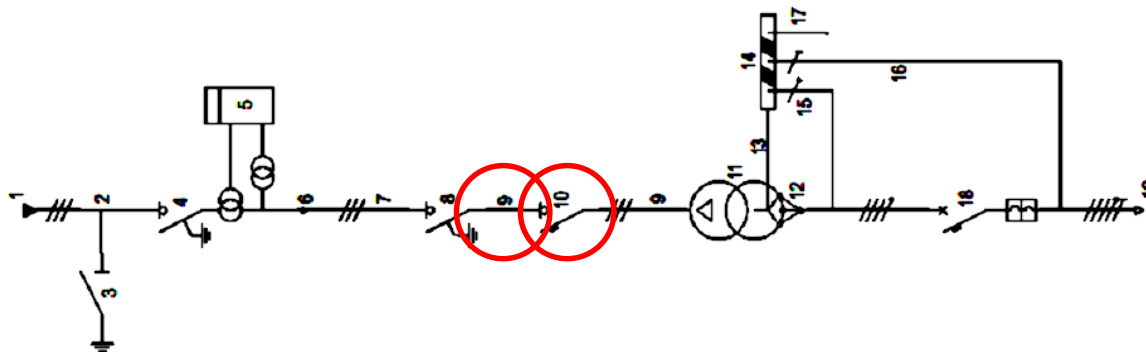


Electrical plants

Supply of electrical energy

The constituent elements of a transformer substation with adjoining the local of delivery of a small plant, with a single transformer, are:

- **connection conductors (9) (bare copper bars or rod), for link their equipment MT. The wires are attached to the elements of the cabin with insulators, which must meet the requirements laid down in the rules;**
- **overcurrent protection device (10), required by the distributing company to prevent a short circuit on the installation of a user is likely to cause disruption to other users. Devices capable of interrupting a short circuit in MT are the circuit breakers (SF6 - hexafluoride zolto and others) and fuses (which must be accompanied by a disconnecting under load);**

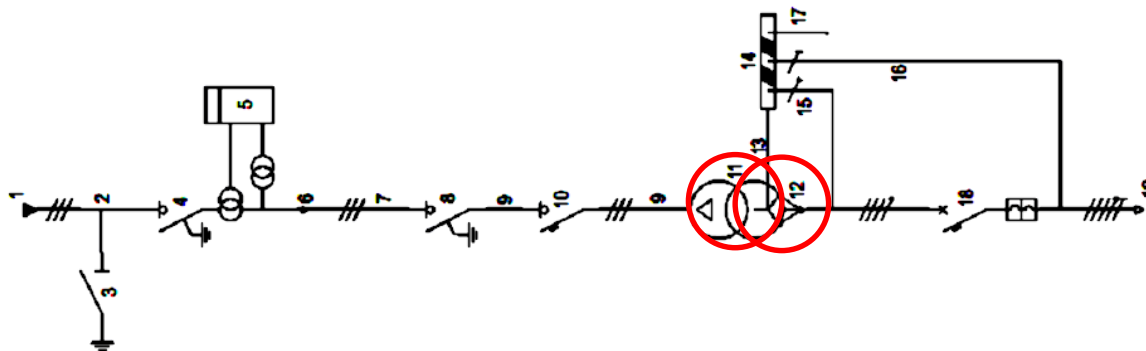


Electrical plants

Supply of electrical energy

The constituent elements of a transformer substation with adjoining the local of delivery of a small plant, with a single transformer, are:

- transformer (11), in mineral oil (at normal or reduced losses) and resin. The oil-filled transformers are cheaper and have losses and dimensions less than those in the resin, but for the presence of oil, which can ignite, special measures should be taken, especially if any fire could cause serious harm;
- manual variator of voltage (12), present on the secondary of each transformer, ensures the proper voltage value to vary the primary voltage, dependent on the position of the cabin;

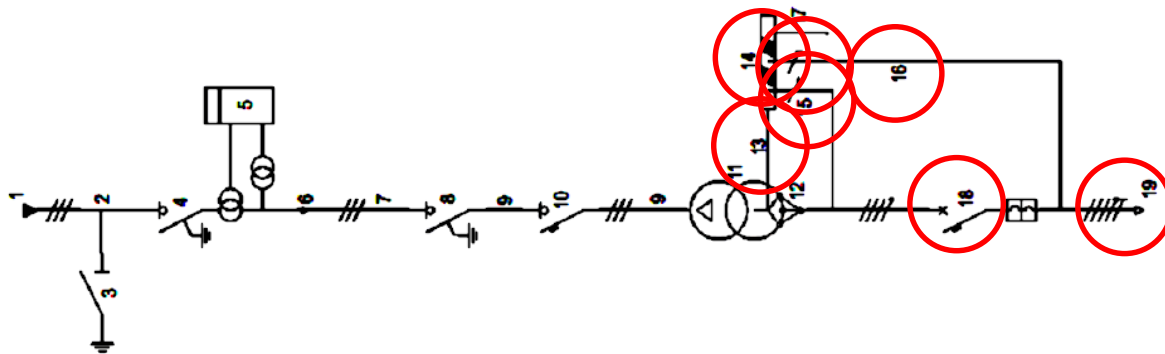


Electrical plants

Supply of electrical energy

The constituent elements of a transformer substation with adjoining the local of delivery of a small plant, with a single transformer, are:

- grounding of the star point of the transformer (13);
- root node of the ground (14), which is constituted by a copper bar of dimensions 30 x 3 x 500 mm, which are connected, by means of bolts the neutral conductors (15), protective (16) and ground (17);
- protective device in BT (18);
- power line in BT of the user system (19).

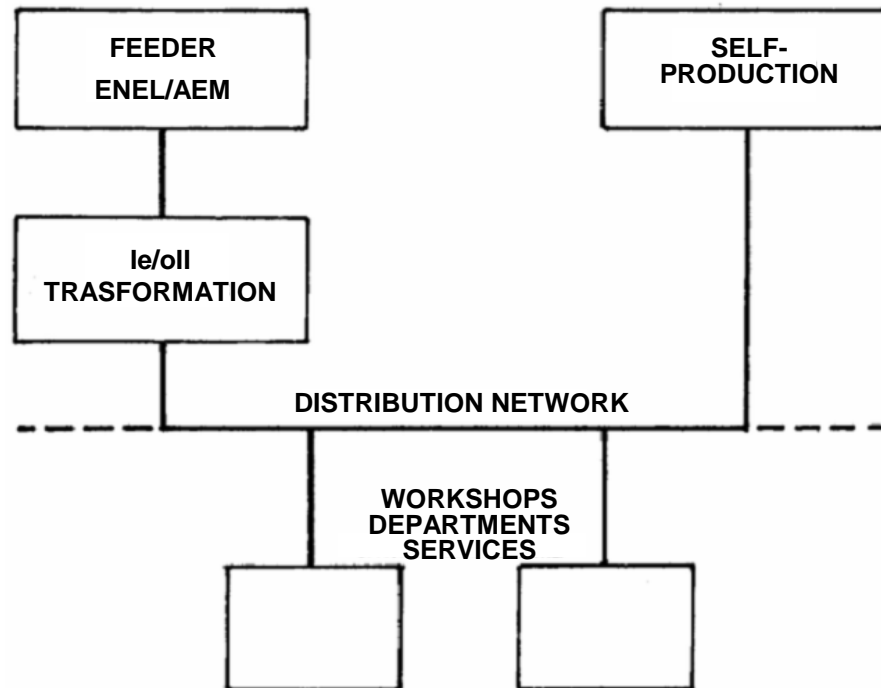


Electrical plants

Supply of electrical energy

After the transformation, or in cases where the current has already the voltage required by the loads, it has to feed the latter through appropriate distribution systems. It is to bring electricity to utilities in a manner sufficiently cheap and reliable.

A block diagram for electrical industrial plants is shown in the figure.



Electrical plants

Supply of electrical energy

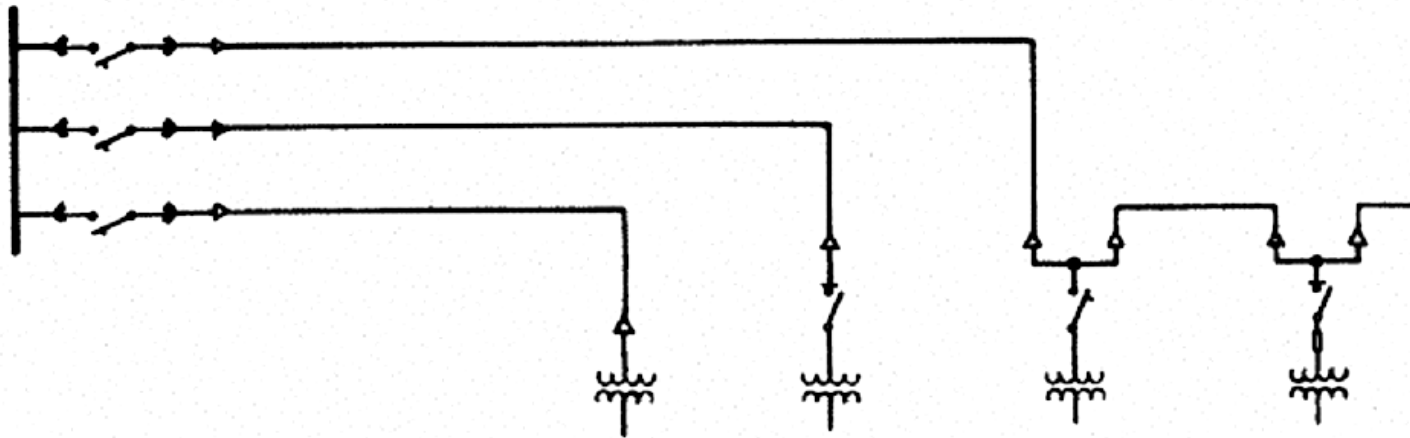
When it relates to the pattern of the distribution network IN MT it can be mainly of three types:

- radial;
- knitting (or ring);
- mixed.

Electrical plants

Supply of electrical energy

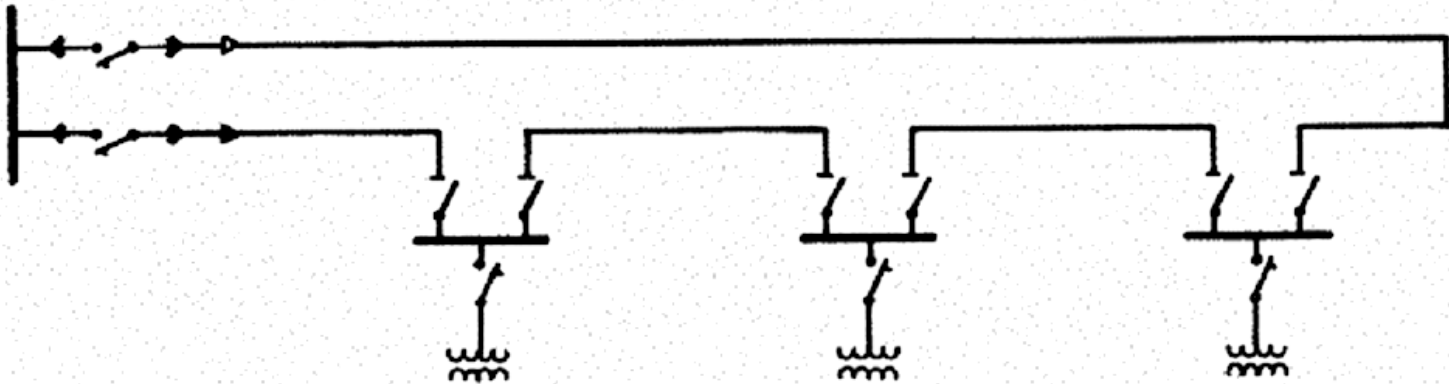
The figure shows a diagram of the distribution in MT with radial distribution.



Electrical plants

Supply of electrical energy

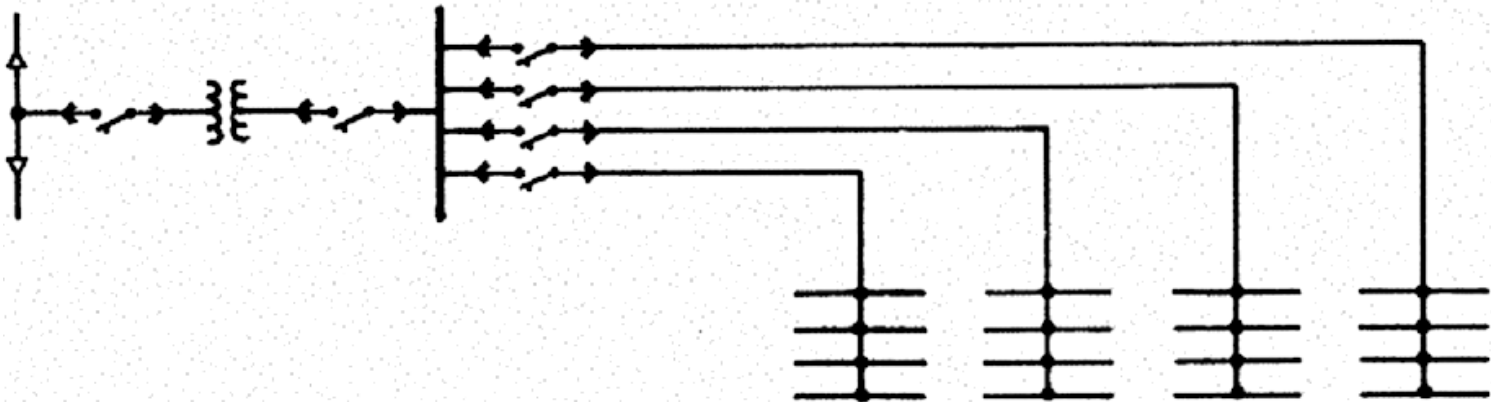
The figure shows that with the distribution in MT to ring.



Electrical plants

Supply of electrical energy

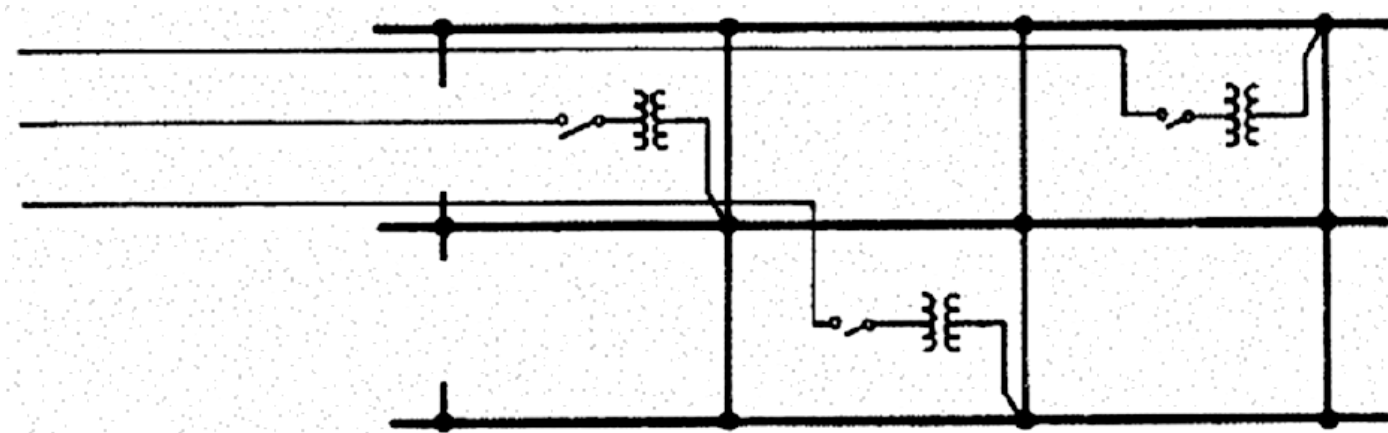
The figure shows a pattern of distribution in BT with radial distribution, with cable lines or "armored" in the cabin protected by switch.



Electrical plants

Supply of electrical energy

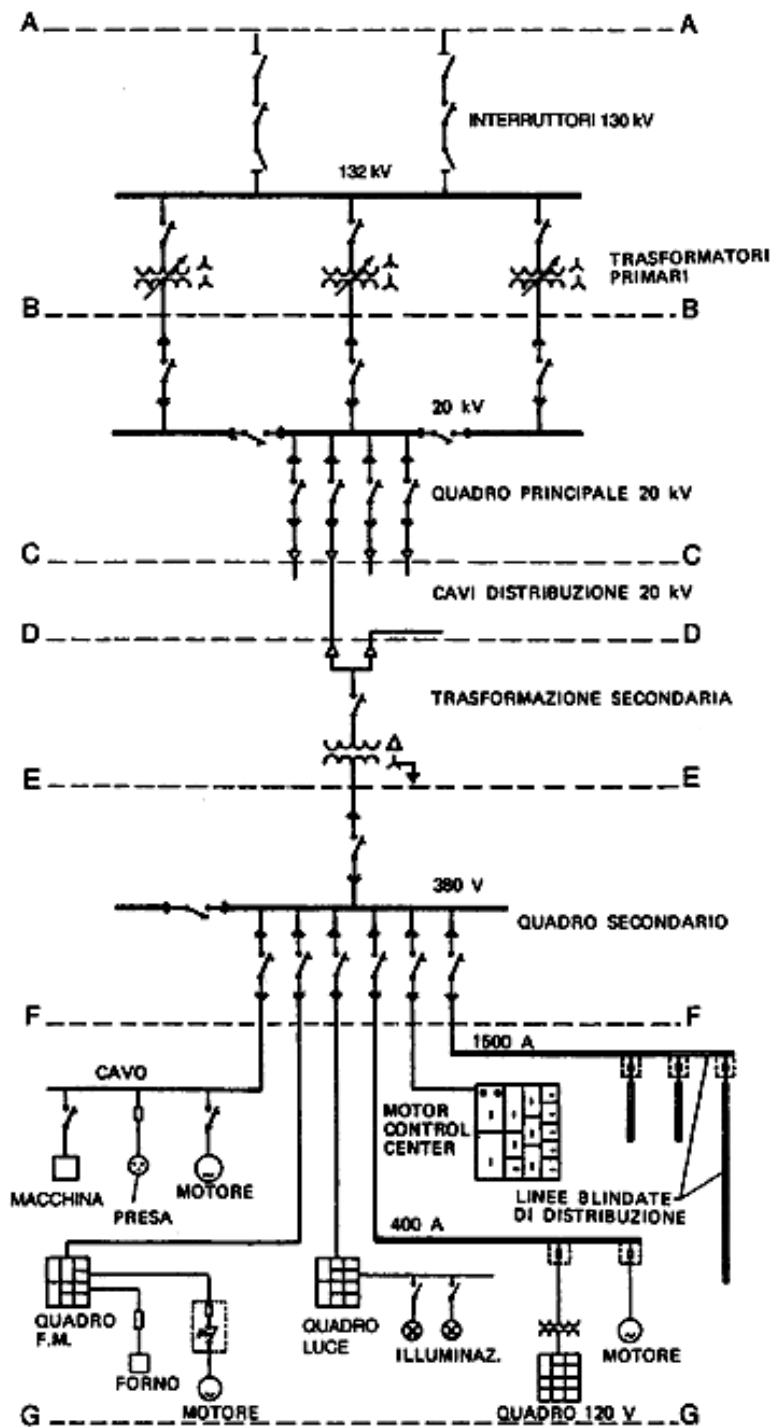
The figure shows the distribution with mesh, with lines forming closed meshes **medium voltage**, nodes protected with fuses or switch breakers.



Electrical plants

Supply of electrical energy

The pattern of distribution system AT, MT and BT is shown in Figure



Electrical plants

Supply of electrical energy

As a general policy, in the industrial field are employed for any voltage cables and busbars, only low voltage. The choice of one or other solution is made by taking into consideration the following aspects in favor of the cables (figure):

- facilit  di installazione e di costo relativamente b
- impedances modest, with equal section, in multicore cables.



It is recalled that the impedance is a physical quantity vector that represents the strength of the opposition of a circuit element to the passage of an alternating electric current, or, more generally, by a variable current. It is expressed as a complex number and is given by the ratio between the voltage phasor and the phasor of the current, commonly indicated with Z and its unit of measurement is the ohm.

Electrical plants

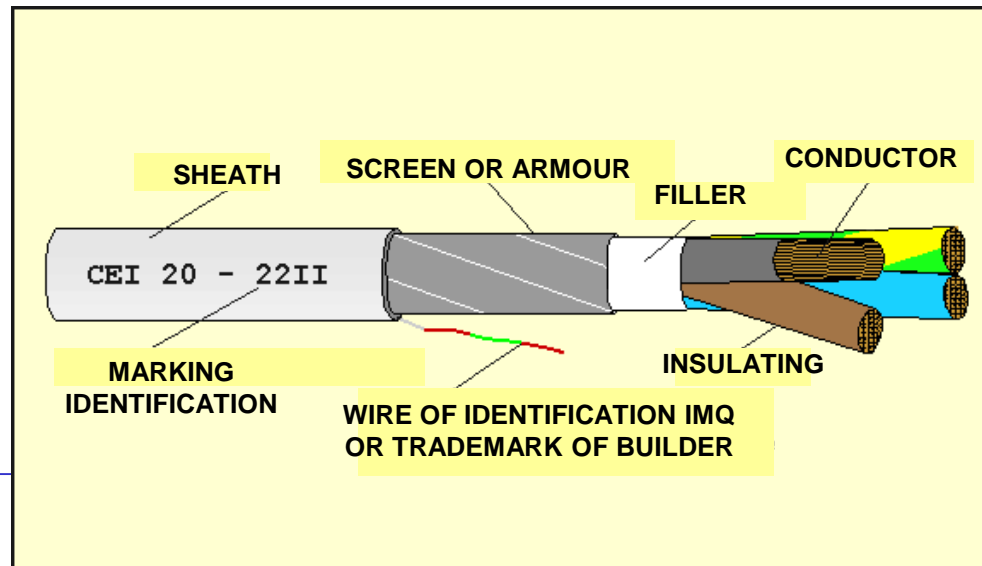
Supply of electrical energy

In favor of the busbar channel (figure):

- ease of installation and reuse;
- possibility of do derivation without changes of the line and with line voltage.



The electric cable is a set of conductors gathered between them (also can be only one), each isolated from the other and towards the outside (figure).



Electrical plants

Supply of electrical energy

The cable core is the set of the conductor and the insulation that covers it. The electrical cables and busbars are used to transmit the electrical energy from one point to another in a plant.

The electrical cables in function of the operating voltage are distinguished in:

- cables for low voltage: are used in systems of class 0 and I;;
- cables for medium and high voltage: are used in systems of category II and III.

Electrical plants

Supply of electrical energy

At the end of the medium-voltage cables are installed the accessories, the so-called "terminal", which adapt the voltage gradients in the transition between the cable insulation and the insulation in the air.

Even the "junctions" between the medium-voltage cables must be carried out with accessories that allow the control of gradients.

Electrical plants

Supply of electrical energy

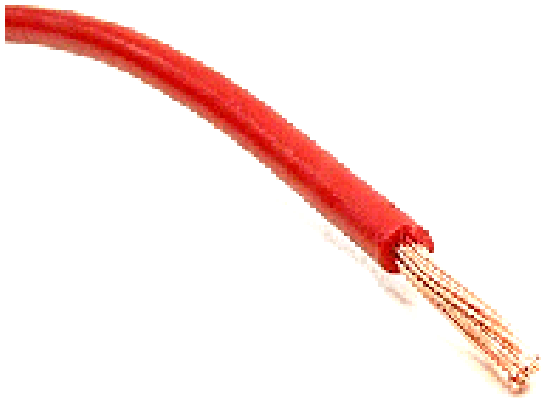
Depending on the type of insulation used the cables are divided into:

- insulated cables with elastomeric material: made from compounds based on natural or synthetic rubber;
- cables insulated with thermoplastic material composed of thermoplastic resins, polyethylene and polyvinyl chloride;
- cables with mineral insulation: based on magnesium oxide, which have good characteristics of resistance to fire. Their outer sheath is made of copper;
- insulated cables impregnated paper: distinct in their turn according to the type of impregnation (normal, oil fluid, gas pressure).

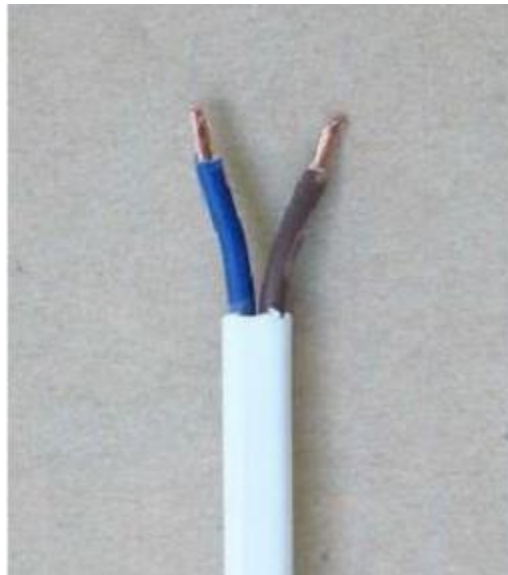
Electrical plants

Supply of electrical energy

A further distinction is made, according to the number of cores in cables unipolar, bipolar, tripolar or multipolar, and depending on the presence or absence of the protective conductor for connection to earth.



Unipolar cable



Bipolar cable



Tripolar cable

Electrical plants

Supply of electrical energy

Finally, it should distinguish between harmonized and non-harmonized cables, the first features have recognized at European level, as complying with the harmonization documents CENELEC (European Committee for Electrotechnical Standardization - Comité européen de normalization en électronique et en électrotechnique) The cables are harmonized normed in the European Union by CENELEC HD 261 and in Italy by the CEI 20-27.

The structure of a cable can be quite varied, depending on the number of souls and of the operating voltage. Not all parts are present in all types of cable, in particular as filling material, the belt and the metal reinforcement are not used in section cables not high, low voltage and not subject to particular mechanical stress.

Electrical plants

Supply of electrical energy

The conductors are made of copper or aluminum, with a prevalence of the first; may be either single-wire (rigid), both in rope (or flexible conductors for high sections).

The copper conductors may be bare or coated, and the coating is made from a thin layer of metal, such as tin, tin alloy or lead alloy.

The insulation is a key part of the cable, because of its characteristics depend on the performance of the cable in terms of isolation voltages, current transmissible and thermal behavior.

Its function is to isolate the conductors between them and towards the mass.

Electrical plants

Supply of electrical energy

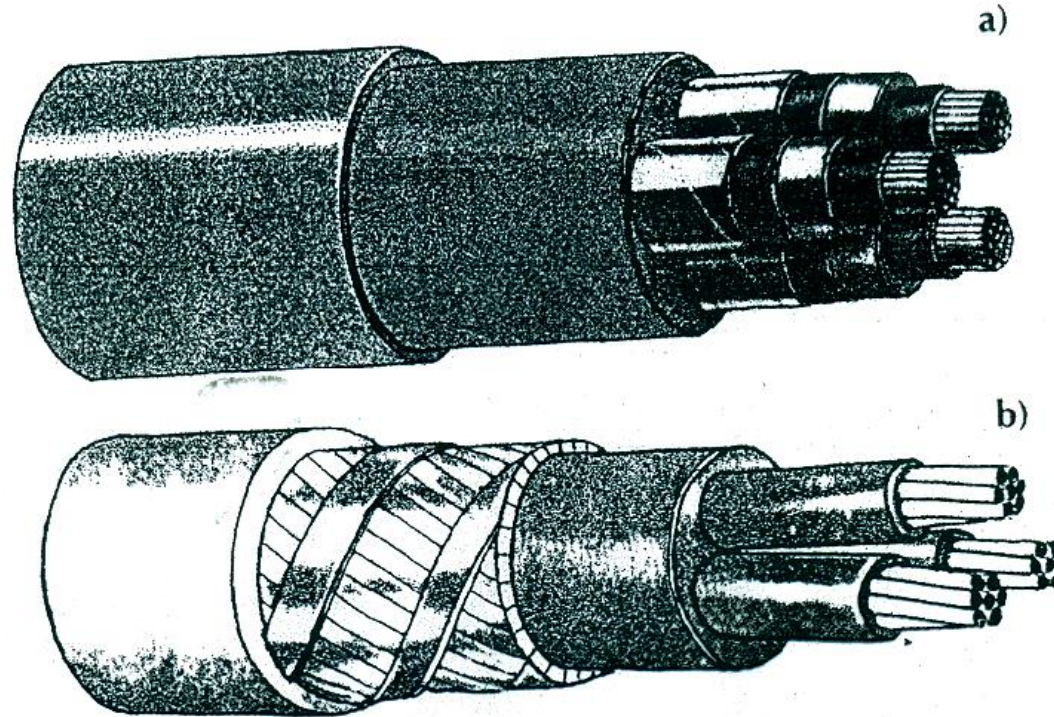
The filler material is present in multi-core cables of high section, is used to fill the interstices between the cores and give the cable a round shape, it is generally composed of textile fibers.

The screen is necessary for cables with a rated voltage of ground insulation greater than 3.6 kV and consists of a thin copper strip coiled and applied on all the souls individually or around the insulation of each, for cables with insulation rated voltage to earth greater than 8 kV;. the CEI standards prescribe the second solution.

The shield serves to change the course of the force lines of the electric field, which is formed inside the cable, so as to decrease the stress on the insulation dielectric and confine the field itself between conductor and screen.

Electrical plants

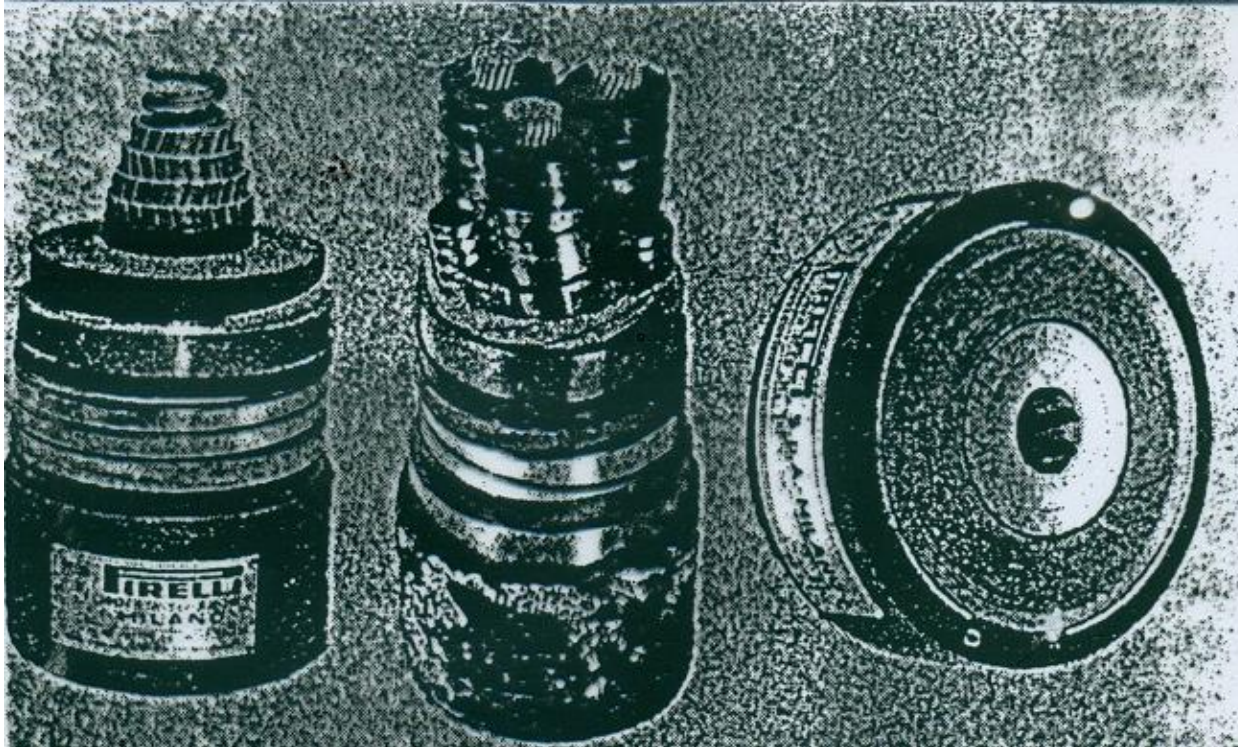
Supply of electrical energy



- a) tripolar cable in copper for medium voltage, for souls cordate, G7 insulation, shielding with copper tape, PVC sheath
- b) tripolar cable in copper for low voltage, for souls cordate, G7 insulation, reinforcement strips of steel, PVC sheath.

Electrical plants

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Cables for high voltage insulation paper and oil under pressure. To the left pole cable channel in the central conductor, the center pole cable with longitudinal channels and to the right instead of single-core cable with a conductor segments (Piorelli)

Electrical plants

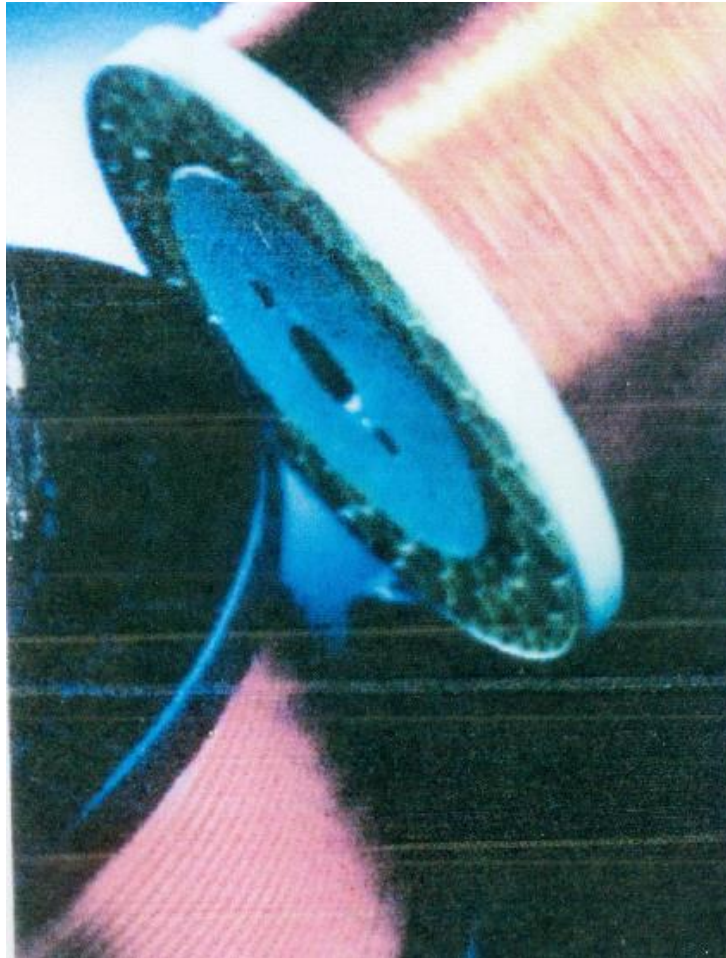
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Cables



Electrical plants

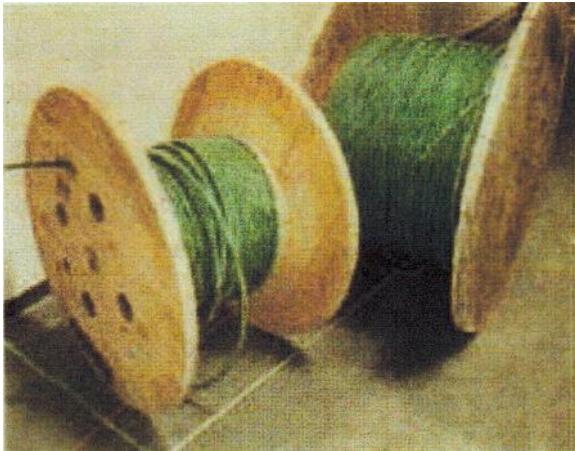
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Conductors of enameled copper

Electrical plants

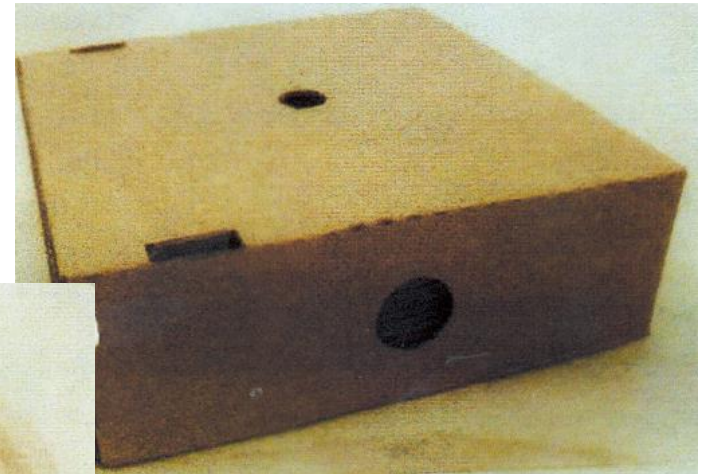
Supply of electrical energy



Coils



Skeins



Boxes

Electrical plants

Supply of electrical energy

Una caratteristica fondamentale per la scelta dei cavi è la portata, cioè, l'intensità massima di corrente che può fluire in ogni conduttore, in determinate condizioni di installazione e il funzionamento, senza che la temperatura supera il consentito dal isolamento, gli altri fattori più importanti da tenere a mente sono:

- nominal voltage of the system;
- section of the phase conductors and any neutral;
- presence or absence of the protective conductor;
- place where the installation must be done;
- way of laying the cable.

Electrical plants

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The channels busbar - often referred to as armored or armored lines - are widely used in industrial installations for the transport and distribution of energy in BT, given the ease of installation, the possibility of recovery and reuse, flexibility in the new provisions of the loads. Manufacturers, in order to respond to changing standards, produce tubes that can be used in harsh environments, with different degrees of protection up to IP65, the conductors are made of copper or aluminum alloy.

Electrical plants

Supply of electrical energy

The **IP Code** (International Protection) is a convention defined in EN 60529 (CEI as implemented by CEI 70-1) to identify the degree of protection provided by enclosures of electrical and electronic equipment (rated voltages up to 72.5 kV) against the penetration external agents of nature, solid or liquid. The IP prefix is followed by two figures:

a) **the first shows the protection against contact with solid bodies and against access to hazardous parts:**

- IP0X = no protection against external solid bodies;
- IP1X = casing protected against solid objects larger than 50 mm and against the access with the back of his hand;
- IP2X = casing protected against solid objects larger than 12 mm and against access with a finger;
- IP3X = casing protected against solid objects greater than 2.5 mm and against access with a tool;
- IP4X = casing protected against solid bodies larger than 1 mm and against access with a wire;
- IP5X = casing protected against dust and against access with a wire ;
- IP6X = casing totally protected against dust and against access with a wire ;

Electrical plants

Supply of electrical energy

The **IP Code** (International Protection) is a convention defined in EN 60529 (CEI as implemented by CEI 70-1) to identify the degree of protection provided by enclosures of electrical and electronic equipment (rated voltages up to 72.5 kV) against the penetration external agents of nature, solid or liquid. The IP prefix is followed by two figures:

b) the second digit identifies the protection against the penetration of liquids:

- IPX0 = no protection ;
- IPX1 = casing protected against vertically falling drops of water ;
- IPX2 = casing protected against falling drops with inclination less than 15°;
- IPX3 = casing protected against rain ;
- IPX4 = casing protected against splashing water ;
- IPX5 = casing protected against water jets ;
- IPX6 = casing protected against waves ;
- IPX7 = casing protected against the effects of immersion ;
- IPX8 = casing protected against the effects of flooding.

Electrical plants

Supply of electrical energy

By way of example, the degrees of protection of the most common applications are:

IP 20:

Apparatus without special protection against ingress of dust and liquids, in which the active parts (the ones that are live in normal operation) are inaccessible to fingers or similar objects.

It 's the minimum degree of protection allowed for components normally used in residential buildings

IP 40:

Devices protected against the penetration of solid bodies with a diameter greater than 1 mm, but not protected against the ingress of water

IP 44:

Apparatus in which, in addition to protection against solid objects described above, is made even protect against splashes.

These devices are employed for use in wet rooms, outdoors and in areas at risk of fire

Electrical plants

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By way of example, the degrees of protection of the most common applications are:

IP 55:

Apparatus protected against the ingress of dust and liquids.

They are suitable for use in places where it is provided for the use of water jets (public baths, stables etc.).

IP 68:

Apparatus suitable for operation in submersion (eg for use in swimming pools, inside the tank, or for the illumination of fountains)

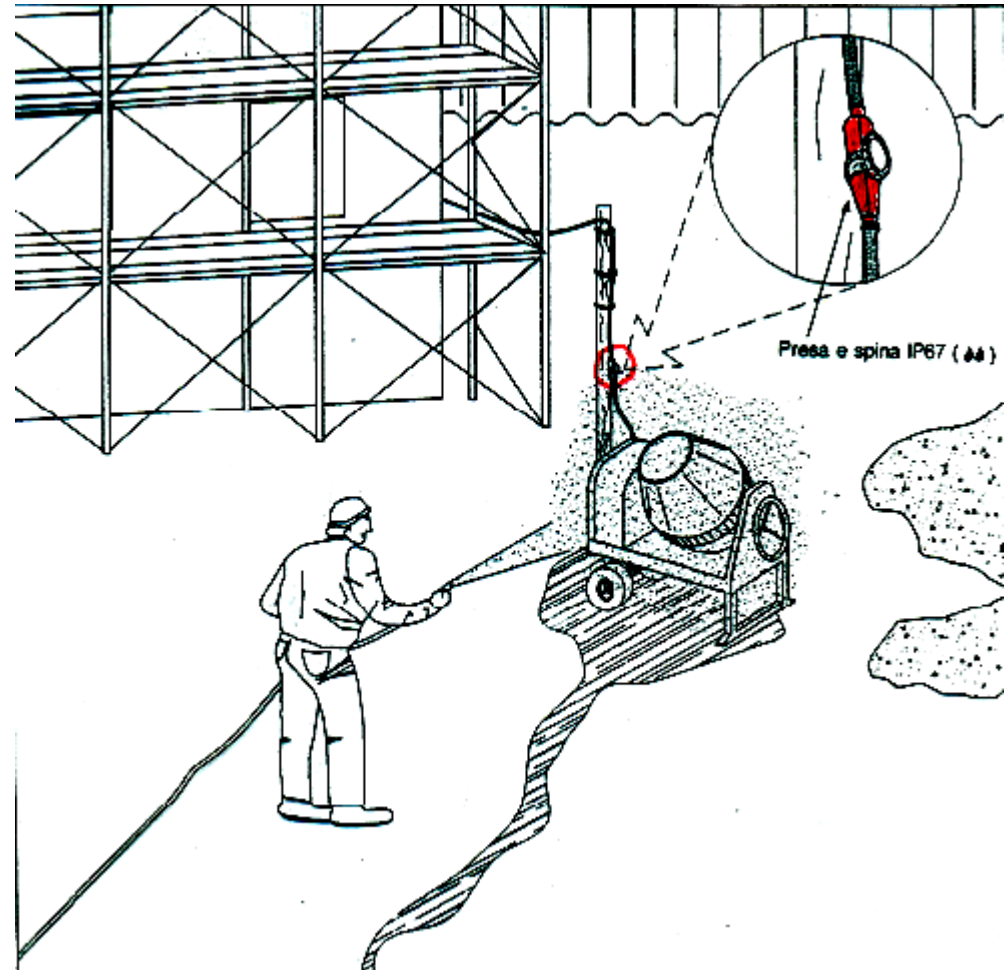
Electrical plants

Supply of electrical energy

Example of

Degree of protection IP 67

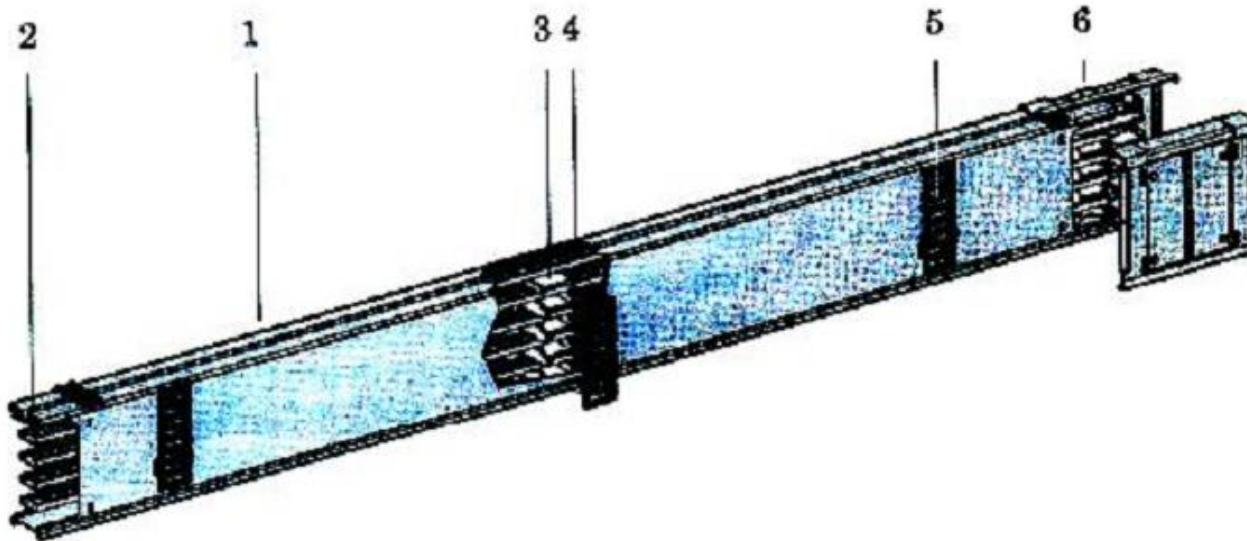
The plug sockets, which can be subjected to jets of water, de-
must have a degree of protection
IP 67



Electrical plants

Supply of electrical energy

The channels busbars are equipped with standard components



A channel busbars (production
Schneider Electric SpA)

- 1) casing sheet
- 2) channels busbars in alluminium
- 3) insulator in polyester reinforced with glass fibers
- 4) protective conductor (PE)
- 5) outlet of derivation
- 6) block junction

Electrical plants

Supply of electrical energy

The channels busbars are equipped with standard components which

- intermediate cable boxes and of headboard;;
- equipment derivation with safety devices and protection by fuses or circuit automatic breaker;
- accessories for attachment to metal structures and masonry;
- expansion joints, fire barrier elements, rain protection.